Job Loss Analysis

Control No: 2000214________ **Status:** __________________ **Original Date:** 2/21/2011

Last Date Closed: ________________

Organization: Refinery

JLA Type: Global Mfg Shared____

Work Type: Technical Process Engineering____

Work Activity: Process engineering Inspection of Heat Exchangers

Personal Protective Equipment (PPE)

☐ Goggles	☐ Hearing Protection	☐ Warning Device	☐ Gloves(Nitrile, rubber, leather)
☐ Face Shields	☐ Hard Hat	☐ Tagout/Lockout kit	☐ Other
☐ Safety Glasses	☐ Safety Shoes	☐ Hi Viz Jacket	☐ Other ___________________
☐ Safety Back Belt	☐ Safety Cones	☐ Welding Hood	☐ Other ___________________

Reviewers

Reviewer Name	Position	Date Approved
Michelle Johansen	Process Engineering Team Lead—Global PED JLA Team Leader	6/23/11

Development Team

Development Team Member Name	Primary Contact	Position
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Job Steps

No.	Job Steps	Potential Hazard	Critical Actions
1.	Understand your objective: 1. Relate process and operation information with mechanical condition of the heat exchanger. 2. Compliment the information obtained by inspectors, design engineers, and metallurgists. 3. More informed decision to implement corrective or improvement measures.	1. Making corrective or improvement decisions based on incomplete or missing information.	1a.Review this document 1b.Consult with BIN leader and heat exchanger specialist.
2.	Be familiar with the heat exchanger to be inspected. 1. Understand the role of the heat exchanger in the process unit. 2. Be familiar with the heat exchanger design and layout. 3. Understand the hot and cold stream properties and operating conditions. 4. Understand the reliability history of the heat exchanger.	1. Do not have sufficient information to interpret observations.	1a. Review PFD of the process unit. 1b. Review heat exchanger drawings. 1c. Review inspection history report. 1d. Review HexMon, pressure survey, and other relevant monitoring data. 1e. Discuss with the process engineer and BIN leader of the process unit. 1f. If the heat exchanger has a history of fouling and other reliability issues review the latest HTRI model and discuss with a heat exchanger specialist.
3.	Obtain Tools required for inspection: 1. Proper PPE. 2. Flash light 3. Digital camera 4. Tape measure 5. Notepad 6. Sample containers and spatula for sampling deposits	1. Cannot perform effective inspection or failure to collect complete data due to lack of tools in the field.	1. Check to ensure all the tools are available.
4.	Dirty inspection of channel and tube sheet.	1. Failure to obtain key information on the fouling / corrosion characteristics of the tube side fluid.	1.Look for: a. Deposits and debris in the channel. b. Debris and deposit on the tube sheet c. Visible tube plugging. d. Review the example pictures with channel and tube sheet inspection at the end of this document.
5.	Dirty inspection of the heat exchanger bundle	1. Failure to obtain fouling and corrosion information for which are key in making decisions on path forward.	1.Look for: a. Visible damages to bundle – bent tie-rods, cracked baffles and support plates, missing or loose parts, etc.

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			b. Deposit morphology. Is the deposit a hard crust on the tube? Flakes? Loose agglomerates between tubes? c. Deposit distribution. Is the deposit more abundant in hot tube-passes, the "dead zones" in the shell, or where the shell side fluid is the hottest? d. Take pictures of deposits and record locations (if not apparent from the pictures) where pictures are taken. e. Confer with BIN leader if sampling of deposits for further laboratory analysis is expected or desired. f. Visible tube or other damages. You may not be able to see damages especially when a lot of deposits are present. Mark their locations and take some pictures. g. For F-shells with lamiflex seals, inspect the seal strips for damages such as cracks and signs that the seal strips were bent the wrong way (towards the low pressure side of the shell). h. Review example pictures of dirty bundle inspection pictures at the end of the document.
6.	Cleaned inspection of the heat exchanger bundle. In addition to inspection prior to cleaning, it is important to perform engineering inspection after inspectors completed their inspection. Inspectors typically mark areas of concerns (damages, leaks, etc.) so that you don't have to hunt for them.	1. Failure to obtain key information required to make informed decision on path forward.	1a.Review inspector's notes and inspection results. Discuss with inspector their key findings Look for: a. Note bundle clean-up method – steaming, hydroblasting, chemical cleaning, etc. Also note effectiveness of cleaning. Are there any deposits still adhere to the tubes or lodged between the tubes? b. Note locations of pitting or pin-hole leaks. Take pictures. c. Note locations of corrosion and leaks from other corrosion mechanisms. Take pictures. d. Metal loss from erosion, typically in regions with high

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			fluid velocity like nozzles. A common example is a well-defined “erosion ring” on the tube where it goes through baffles. Take pictures. e. Tube cracks. There are many causes for tube cracking. It could be due to incompatibility of the process fluid and the metal or from flow-induced vibration. Take pictures. f. Review example picture of clean bundle inspection at the end of the document. 1b. It is crucial to mark the location of the concerned areas. Take pictures! Note that you cannot see the middle of the bundle. Pay attention to the inspector’s markings. If they found issues inside the bundle, tube leak for example, at least you know they are there.
7.	Shell ID inspection	1. Failure to obtain key information required to make informed decision on path forward.	1.Things to look for: a. General scratches from bundle handling. This is especially important for clad shells. b. Deposits, pits and other corrosion damages. Note locations and take pictures.
8.	Channel ID inspection	1. Failure to obtain key information required to make informed decision on path forward.	1.Things to look for: a. Corrosion / erosion on the channel wall and on the partition plates. b. Bowing of the partition plates. That may indicate high pressure drop across the tubes.
9.	Data consolidation and analysis	1. May miss key information and observation required to make informed decision on path forward.	1a. Collect and review inspection data. Common inspection techniques: • ECT (Eddy Current) • IRIS (Internal Rotational Inspection System) Discuss findings with inspectors if you’re not familiar with the techniques and how to interpret the results. 1b. Try to correlate operations issues, corrosion, and damages

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			observed with fluid properties and the design characteristics of the heat exchanger. For example, the deposit on the bundle may be more abundant where the shell side fluid is the hottest. Consult with specialists in the Company – BIN leaders, metallurgists, and heat exchanger specialists. 1c. Use data to determine the maximum number of tubes that can be plugged based on velocity and heat transfer requirements.
10.	Make decision on path forward. Common options: 1. Cleaning only 2. Plug damaged tubes 3. Repair damages parts such as weld repair of baffles and tube sheet. 4. Minor bundle modification such as replacing an impingement plate with impingement rods. Bundle re-tubing or replacement	1. Increase EII due to poor energy recovery The heat exchanger may limit process unit performance or feed rate. Unplanned shutdown from heat exchanger failed online.	1. Work with specialists – inspectors, metallurgists, BIN leaders, heat exchanger specialists to determine the path forward. Keep in mind the focus of inspectors and metallurgists are on reliability and to ensure the equipment does not pose reliability issues until the next scheduled turnaround. It is the engineer's responsibility to ensure the equipment performs as expected between turnarounds.
11.	Observe the installation of heat exchanger bundles after cleaning.	1. Incorrectly installed bundles can lead to poor performance, high energy use, and unplanned turnarounds.	1a. For multi-shell arrangements, ensure that the correct bundle is installed in each shell. In some cases the metallurgy and bundle design such as baffle spacing and tube wall thickness are different even though the shell and bundle diameters are the same. 1b. For F-shell exchangers with lamiflex seals, the seal strips must be replaced after every bundle removal. 1c. For F-shell exchangers, ensure that the lamiflex strips are of the correct metallurgy to prevent corrosion and installed such that they cup toward the incoming flow (high pressure side). Guide the lamiflex seal into the shell with a thin metal strip if there are possibilities of kinking or other damages. Lamiflex seal damage is one of the most common root causes of F-shell heat exchanger reliability.

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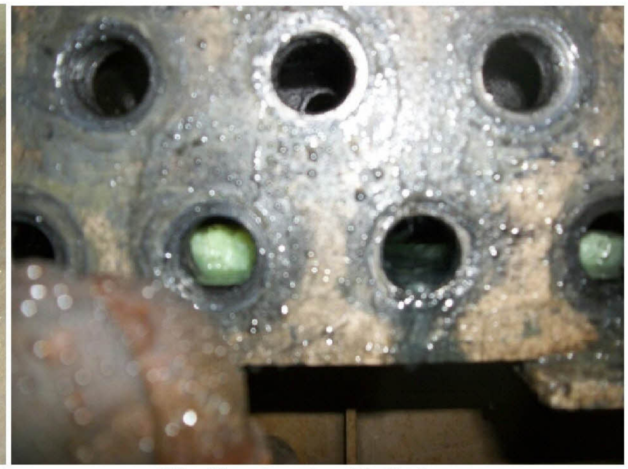
Pictures of Dirty Tube sheet and Channel Inspection

Tubesheet Fouling from Cooling Tower Debris



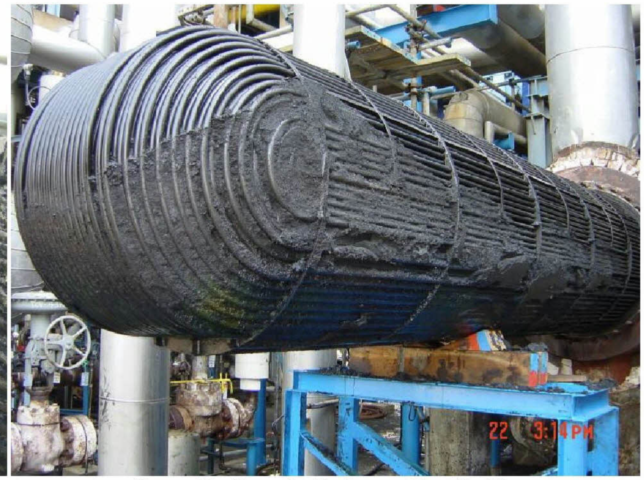
Wax Plugging of an Air-Cooler

Debris from Cooling Tower Found in Channel

Severe Tube Plugging from CW Chemical Precipitation

Pictures of Dirty Inspection of Tube Bundle

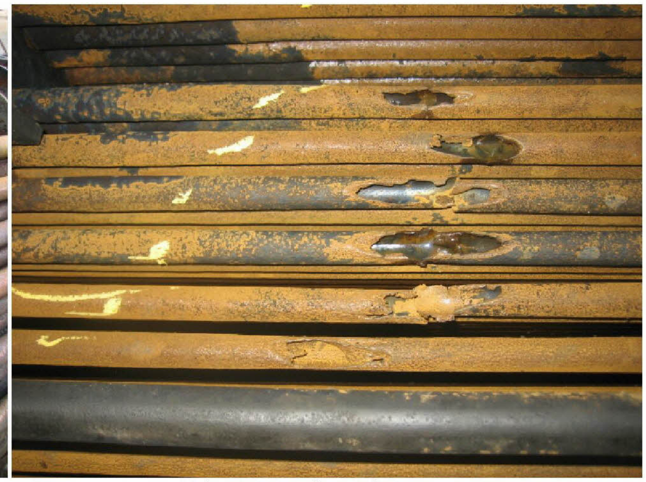
Severe Fouling of a Exchanger Bundle (1)



Severe Fouling of a Exchanger Bundle (2)

Pictures of Clean Inspection of Tube Bundle

Tube OD Corrosion from Salt Precipitation



Tube Rupture from Thinning

Tube Damage from Pitting Through

Severe Corrosion from Salt Deposit